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Improving QoS Metrics in Dynamic Bandwidth Allocation Of Wireless Mesh Community Networks

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Abstract: Wireless networks are the emerging technology that is aimed at providing various internet services. Wireless mesh networks serve as a means to provide internet access but with a limitation of maintenance costs. Instead of a single WMN operator incurring huge maintenance costs, it can simply use the policy of divide and conquer in allocating the available bandwidth. The WMN operator can distribute its bandwidth to a set of customers which in turn can be provided to the users intended for accessing the internet services. This work represents the overall idea of an allocation mechanism in the form of an bandwidth auction. To ensure fair auction mechanism greedy mechanism is used which works well even for large scale networks. Results and analysis shows that this auction mechanism performs efficiently.

*Keywords:*Wireless Mesh Networks, Reliable Auction Mechanism, Greedy Algorithm

I INTRODUCTION

Wireless mesh community networks are an emerging area of network access formed in order to exploit the access bandwidth. The mesh network involves independent mesh routers owned by different individuals. The network operator leases his bandwidth to these individuals and they in turn sublease it to the users who wish to access this bandwidth on a commercial basis. This pattern helps to reduce the maintenance costs and management overhead. Mesh networks have been deployed with both multi-radio and single-radio solutions. Single-radio mesh solutions use a single radio device, or transceiver, to provide wireless access to the end user and connectivity on the backhaul mesh network. The single-radio solutions, while benefiting from a simpler design, typically suffer from significantly diminished overall throughput that limits the scalability of the overall network. Usage of these devices typically results in either smaller coverage areas and/or lower available bandwidth to users compared to mesh networks built around multi-radio devices. In contrast, multi-radio mesh designs allow separation of the user access and mesh backhaul operations of the wireless network, resulting in greater capacity for both network layers. This allows better scaling performance for the overall mesh network. Two radios per mesh node (routers) is typically sufficient to realize the benefits of separation of the user access and mesh planes, with more radios providing marginal performance gains and additional per-unit cost.

Mesh nodes contain a WiFi radio operating as an access device and a second WiFi radio that participates in a local wireless mesh network. The primary functions of a mesh node include the provision of 802.11 access point capabilities and the forwarding of local and relaying of remote user traffic from other mesh nodes to and from the Internet via the injection and backhaul layers. Additional functions may include the enforcement of QoS rules for outbound traffic, as well as acting as endpoints for securing over-the-air traffic between subscriber and 802.11 access point.

Mesh gateway is responsible for passing traffic between a collection of mesh nodes and the backhaul network, serving as the single egress point for these nodes. A mesh gateway role is assigned to a standard mesh node upon deployment; however, mesh nodes dynamically select their mesh gateway based on shortest routing path. This approach allows mesh nodes to re-select an alternate gateway if the current one becomes unavailable.

A mesh neighborhood is comprised of a number of mesh nodes that are logically and functionally controlled by and associated with a single mesh gateway. At a minimum, a mesh neighborhood consists of one mesh node and an associated mesh gateway, although in practice the number of mesh nodes is expected to be much larger in order to extend the reach and coverage of the wireless network and reduce the number of injection layer links

II. RELATED WORK

'A Survey on Wireless Mesh Networks' a work produced by Ian F. Akyildiz, Xudong Wangprovide abetter understanding of research challenges of this emergingtechnology. The advantages produced in their work was that the throughput capacity can be increased by deploying relayingnodes. But they suffered drawbacks in terms ofAvailable MAC and routing protocols being not scalable as well asthroughput drops significantly as the number of nodes or hopsin WMNs increases.

Wireless Community Networks:An Alternative Approach forNomadic Broadband Network Accesswhose authors *Pantelis A. Frangoudis and George C. Polyzos* presented the incentivemechanisms that regulate wsn operationbroadband Internet access canbe achieved at a low cost, at least in metropolitanAreas.Issues such as the incentives of private WLANowners to permit public access to their APs andrelevant security concerns need to be resolved was the major drawback identified.
TRUST: A General Framework for Truthful DoubleSpectrum Auctionsleveraged by Xia Zhou and Heather Zheng proposed a framework for Truthful double Spectrum auctions (TRUST)achieving truthfulnessTRUST makes an important contributionon enabling spectrum reuse to minimize such tradeoff. These schemes suffered the disadvantage of auctions without the propertybeing extremely vulnerable to market manipulation and producevery poor outcomes.Revenue Generation for Truthful Spectrum Auction inDynamic Spectrum Accessanother work of JunchengJiaQianZhang andMingyan Liuwhich presented a secondary spectrum market where a primary license holder can sell access to its unused.Simulation results show that this suboptimal auction can generatestable expected revenue.Under static allocation, spectrum resources are not being efficientlyutilized.

III.THE DESIGN

This section presents the communication and network modelsconsidered in our work, as well as the definitions and assumptions we adopt in the design of our auction mechanism. Let us refer to the WMN scenario illustrated in Fig. 1, where the WMN is managed by a single operator that leases the bandwidth made available through its mesh access points (MAPs) to a subset of customers, which connect to the WMN though their mesh clients (MCs). The mechanism we propose implements the bandwidth marketplace by allocating the available WMN capacity to a subset of customers, which in turn may sublease it to other residential users. Each mesh client3 has a bandwidth demand that he wishes to satisfy by transmitting to one of the MAPs that cover it with their wireless signal. We assume, without loss of generality, that the term accounts for the traffic demand of both the downlink and uplink since the wireless resource is a half-duplex channel. The uncertainty related to traffic description in 802.11 wireless systems can be broadly characterized by three parameters, namely: 1) its burstiness; 2) the packetlength distribution; and 3) the contention level at the frame layer, which, in turn, is closely related to the collision probability.

ALGORITHM:

Step 1. Begin

Step 2. Give input as the number of clients, mesh clients, and the bids being made.

Step3. Compute channel utilizations

Step 3. Compute virtual bids for each client

Step 4. Compute the demands of the clients

Step 5. Calculate a binary value x_i which represents that the demands of the clients being satisfied or not

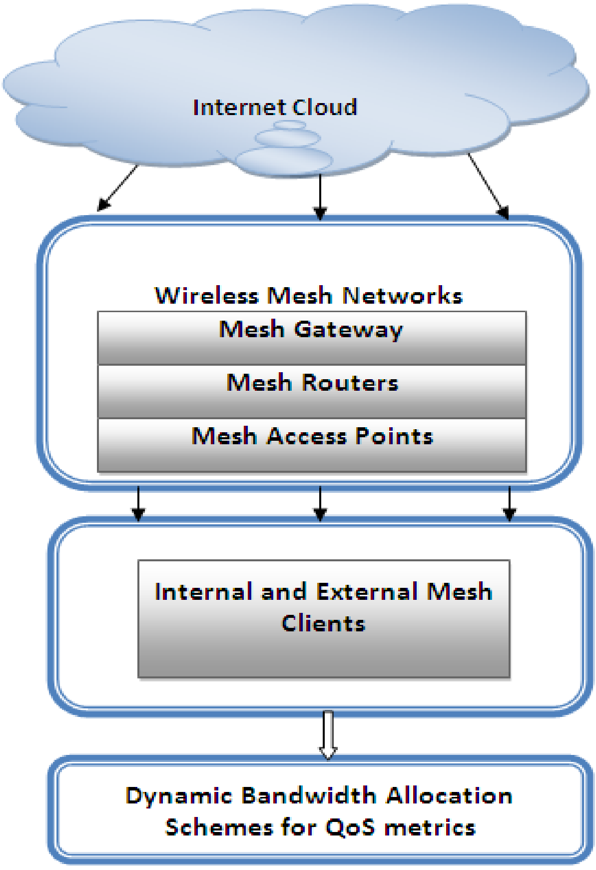
Step6. Follow MILP model to calculate the value of x_i

Step 7. Calculate the maximum price by using the above parameters.

Step 8. Allocate the customer with the highest bid made in the above step

Step 9. End

B. THE SYSTEM ARCHITECTURE



3.2 SYSTEM MODULES

3.2.1 Mesh Network:

Each mesh client has a bandwidth demand that he wishes to satisfy by transmitting to one of the MAPs that cover it with their wireless signal. Without loss of generality, that the term accounts for the traffic demand of both the downlink and uplink since the wireless resource is a half-duplex channel.

3.2.2 Optimal and Truthful Bandwidth Auction Implementation:

To allocate the available access bandwidth of a WMN operator, maximizing its expected revenue. We formalize the optimal and truthful auction mechanism in two steps. First, we present a mixed integer linear programming (MILP) model that gives the optimal solution for the Optimal and Truthful Bandwidth Allocation Problem (OTBAP). Solving OTBAP, we obtain the assignment of MCs to MAPs that maximizes the expected revenue of the WMN operator.

To meet this latter necessity, design an optimal truthful Dutch auction that forces each customer concerned in leasing the offered bandwidth to bid its real estimation of the required bandwidth demand. The approach consists in finding the best possible set of customers to be accepted by the operator (auction winners), whose traffic anxiety can be routed through the WMN, and the analogous prices they have to pay for the leased service, which constitute the operator revenue. The optimal allocation and the pricing together make the auction truthful.

3.2.3 Greedy Bandwidth Auction Implementation

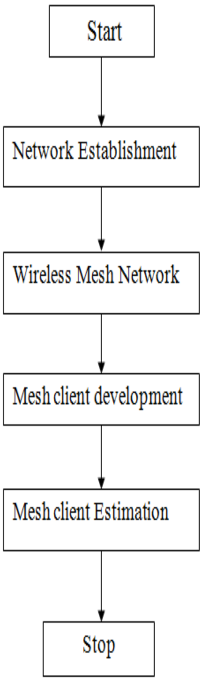
The Optimal and Truthful Bandwidth Auction Problem is NP-Hard. Finding the exact system optimum can be thus extremely time-consuming, especially in large-scale, real wireless network scenarios as those analysed in our numerical evaluation. The number of bidders from 100 to 1500 with a step of 100, and set the number of channels to be 15, 20, and 30. The bidders are randomly deployed in a square area of 5000m×5000m. Each bidder has an interference range of 425m. Any pair of bidders who lie within each other's interference range are in conflict, and thus cannot be allocated on the same channel simultaneously.

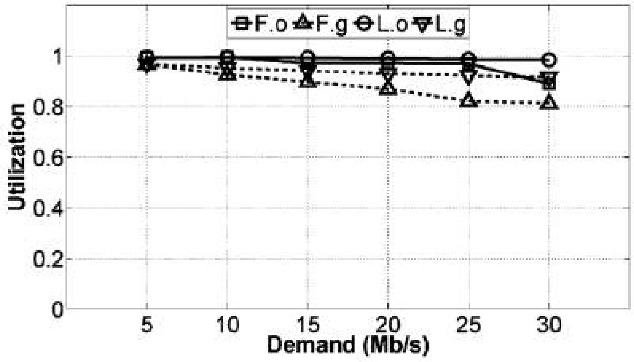
5.2.4 Dynamic Bandwidth Allocation Scheme (Modified work)

The revenue obtained using the greedy algorithm approaches that obtained using the optimal mechanism since the optimal revenue is only times larger than the revenue computed using the greedy algorithm. Allocation mechanism can be modified to bound the Price of Anarchy of the Social Welfare by simply fixing a minimum amount of bandwidth demand for any bidder that is willing to participate to the auction. It presents a dynamic slot scheduling scheme which efficiently distributes the unused TDMA time slots among the needy nodes

This scheme can effectively allow all ONUs to fairly share the uplink bandwidth according to their bandwidth demands. That is, TLBA ensures all service classes to proportionally share the bandwidth on the ratio of the demand of a single class to the total demand. Within the same service class, all ONUs are allocated the bandwidth with equal rights according to the max-min policy. Since the OLT allocates a minimum bandwidth to every service class even if the overall load is heavy, the minimum throughput of each class can be guaranteed. In addition, the weights can be adjusted artificially to change the proportion of bandwidth shared by each service class under heavy load.

5.3 FLOW DIAGRAM





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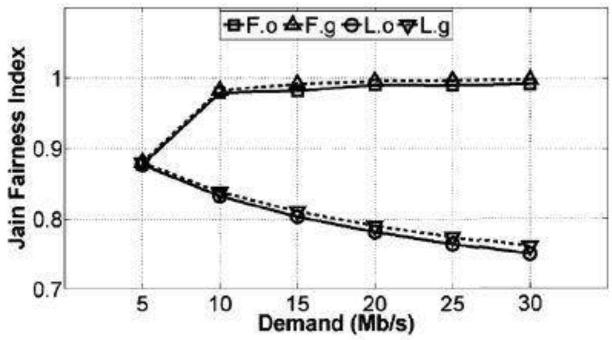
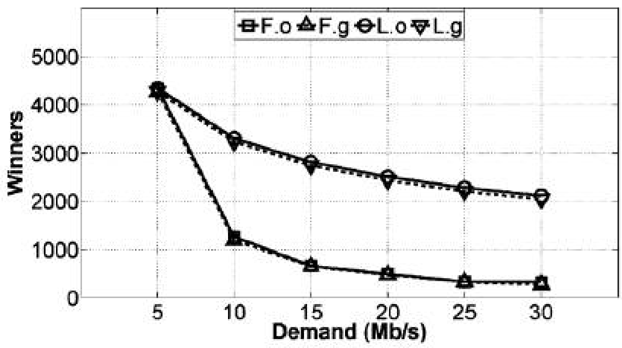


(c)

IV.PERFORMANCE ANALYSIS

The maximum computational time we measured to solve the problem on a Pentium 4 with 3.0 GHz and2 GB of RAM was approximately equal to 40 h. Conversely, the greedy approach takes always less than 30 s to find efficient allocations and the corresponding payments.



(a)

V.CONCLUSION

To allocate available bandwidth of a WMN operator to those customers based on requirement, two effective mechanisms proposed.Allocation mechanism as a combinatorial auction – which guarantees real valuation of the required bandwidthGreedy algorithm that finds efficient allocations in polynomial time even for large-scale, real network scenarios while maintaining the truthfulness propertyDynamic Bandwidth Allocation schemes improvised the QoS Performance Metrics. Numerical results show that the greedy algorithm with Dynamic Bandwidth Allocation schemes performs very close to the optimal combinatorial auction, thus representing an efficient, fair, and practical alternative for solving the auction of the proposed bandwidth marketplace.

A framework for QoS support and fair rate allocation in wireless mesh networks. Our framework uses link contention graph and utility maximization framework to perform admission control and rate allocation. k, we have considered throughput and delay as QoS performance metrics. Uses of other parameters like jitter and packet loss are left as a part of future work

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